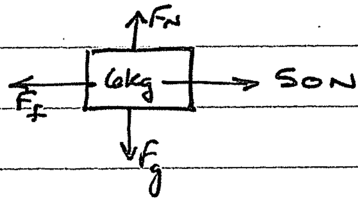
FRICTION, NEWTON'S LAWS + KINEMATICS

#1 

constant velocity!!

(a) $F_a = 50N$

(b) $F_f = 50N \quad \because F_{NET} = 0N$

(c) $F_g = mg$
$= 6(9.8)$
$= 58.8N$

(d) $F_N = 58.8N \quad \because F_{NET} = 0N$ VERT.

(e) $F_f = \mu F_N$
$50 = \mu\, 58.8$
$\mu = 0.85$

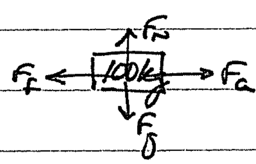
(f) μ_k $\because$ object is moving

#2 $\mu_k = 0.35$
$m = 5.0kg$
$F_f = ?$
$F_N = F_g = mg$
$= 5(9.8)$
$= 49N$

$F_f = \mu_k F_N$
$= 0.35(49)$
$= 17.2N$

#3 $m = 70kg$
$\mu = 0.010$
$F_f = ?$
$F_N = F_g = mg$
$= 70(9.8)$
$= 686N$

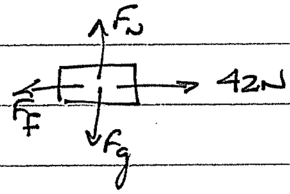
$F_f = \mu_k F_N$
$= 0.01(686)$
$= 6.86N$

#4 Const. vel. 

$F_a = F_f = 880N$
$\because F_{NET} = 0$

$F_f = \mu F_N$
$880 = \mu(mg)$
$880 = \mu(100 \cdot 9.8)$
$\mu = 0.898$

#5



$F_f = 42N \quad \because F_{NET} = 0N$

$m = 5.0kg.$

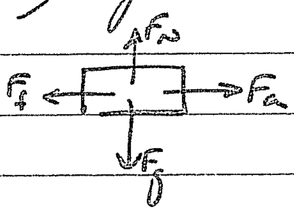
$\mu = ?$

$F_f = \mu F_N$

$42 = \mu(mg)$

$\mu = 0.857$

#6 uniform vel. !!



$F_f = F_a = 180.3N \quad \because F_{NET} = 0N$

$\mu = 0.20$

m ~~F_f~~ $= ?$

$F_N = mg$

$F_f = \mu F_N$

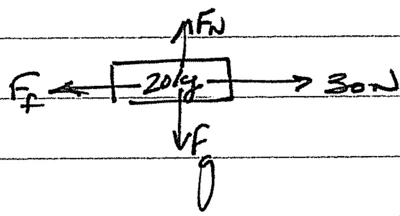
$180.3 = 0.2(mg)$

$901.5 = mg$

$m = 901.5/9.8$

$= 92 \text{ kg}$

#7



(a) $m = 20kg$

$F_a = 30N$

$\therefore F_f = 30N$ assuming unif. vel.

$\mu = ?$

$F_f = \mu F_N$

$30 = \mu(mg)$

$30 = \mu(20 \cdot 9.8)$

$\mu = 0.153$

(b) $m = 20 + 2(60) = 140 \text{ kg}$

$F_a = ?$

→ assuming unif. velocity →

$F_a = F_f = \mu F_N$

$= 0.153(140 \cdot 9.8)$

$= 210N$

#8 $t = 8.95\,s$

$m = 150\,g = 0.15\,kg$

$V_1 = 25.2\,km/h = 7\,m/s$

$\Delta d = 32\,m$

$\mu = 0.080$

(a) $F_g = mg$

$= 0.15(9.8)$

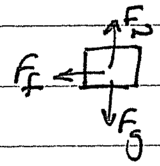
$= 1.47\,N$

(b) $F_f = \mu F_N$

$= (0.080)(1.47)$

$= 0.118\,N$

(c) While puck is travelling towards the goal:



$F_{NET} = F_f$

$= 0.118\,N$ backwards

(d) $\vec{F}_{NET} = m\vec{a}$

$-0.118 = 0.15\,\vec{a}$

$\vec{a} = -0.784\,m/s^2$

(e) $\vec{V}_2 = \vec{V}_1 + \vec{a}\Delta t$

$0 = 7 - 0.784\Delta t$

$\Delta t = 8.93\,s$

#9 $m = 55\,g = 0.055\,kg$

$t = 0.0050\,s$

$\vec{V}_1 = 30\,m/s\,[E]$

$\vec{V}_2 = 40\,m/s\,[W]$

(a) $\vec{a}$:? $\quad \vec{V}_2 = \vec{V}_1 + \vec{a}\Delta t$

$40\,m/s\,[W] = 30\,m/s\,[E] + \vec{a}(0.005)$

$40\,m/s\,[W] - 30\,m/s\,[E] = 0.005a$

$70\,m/s\,[W] = 0.005a$

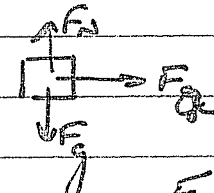
$\vec{a} = 14000\,m/s^2\,[W]$

(b) $\vec{F}_{NET} = m\vec{a}$

$= 0.055(14000)$

$= 770\,N\,[W]$

(c)

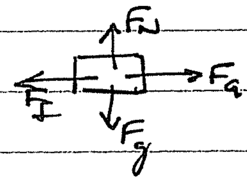


$F_a = F_{NET} = 770\,N\,[W]$

#10 $m = 30\,kg$

$F_a = 160\,N$

$\mu = ?$



(a) $F_f = F_a = 160\,N$

(b) $F_f = \mu F_N$

$160 = \mu(mg)$

$\mu = 160/294$

$= 0.544$

#11 $m = 100\,kg$

$\vec{V}_1 = 88\,km/h = 24.44\,m/s$

$\vec{\Delta d} = 100\,m$

$\vec{V}_2 = 0\,m/s$

(a) $V = 24.44\,m/s$

(b) Newton's 1st

(c) $\vec{V}_2^{\,2} = \vec{V}_1^{\,2} + 2a\Delta d$

$0 = 24.44^2 + 2\vec{a}(100)$

$\vec{a} = -2.99\,m/s^2$

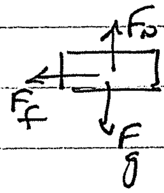
(d) $\vec{F}_{NET} = m\vec{a}$

$= 100(-2.99)$

$= -299\,N$

-ve indicates direction

(e)



$F_f = F_{NET} = -299\,N$

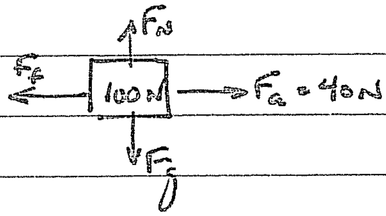
(f) $F_f = \mu F_N$

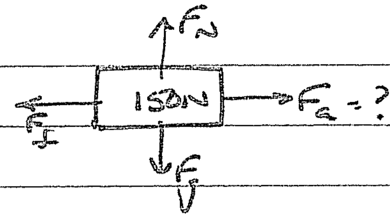
$299 = \mu mg$

$299 = \mu(980)$

$\mu = 0.305$

#12





Same surfaces ∴ μ is same for both

∵ $F_{NET} = 0N$

∴ $F_a = F_f = 40N$

∴ $F_f = \mu_s F_N$

$40 = \mu_s (mg)$

$40 = \mu_s (100)$

$\mu_s = 0.40$

→ $\mu_s = 0.40$

$F_f = ?$

$F_f = \mu_s F_N$

$= 0.40(150)$

$= 60N$

∴ $F_a = 60N$

∵ $F_{NET} = 0N$

#13 $m = 46g = 0.046\ kg$

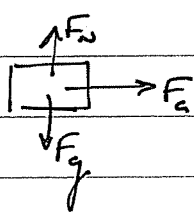
$\vec{V}_1 = 0\ m/s$

$\vec{V}_2 = 252\ km/h = 70\ m/s$

$\Delta t = 0.005s$

$\vec{a} = \Delta\vec{v}/\Delta t$

$= 14000\ m/s^2$



$F_{NET} = ma$

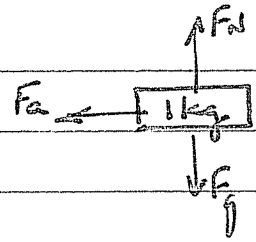
$F_a = (0.046)(14000)$

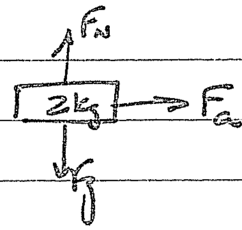
$= 6440N$ ← $F_{club\ on\ ball}$

$F_{ball\ on\ club}$ = RXN FORCE = 6440N

#14

a)





$a = 10\,m/s^2$, $m = 2\,kg$ } $\vec{F}_{NET} = m\vec{a} = 2(10) = 20N$

b) F of 1kg mass on 2 kg mass = $F_a = F_{NET} = 20N$

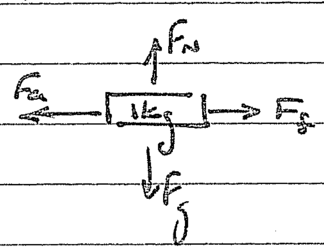
c) F of 2kg mass on 1 kg mass = 20N (rxn force).

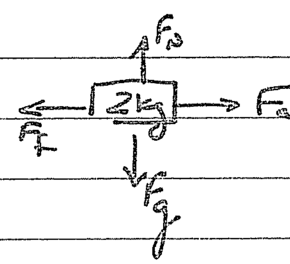
d) $F_{NET} = ma$

$20 = 1(a)$

$\vec{a} = 20\,m/s^2$ (backwards).

e) IF FRICTION IS PRESENT





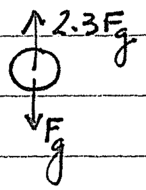
$F_f = \mu F_N = 0.05(mg) = 0.49N$	$F_f = \mu F_N = 0.05(mg) = 0.98N$
$F_a = F_{repulsion}$ is still 20N	$F_a = F_{repulsion}$ is still 20N
$\therefore F_{NET} = 20 - 0.49 = 19.51N$	$\therefore F_{NET} = 20 - 0.98 = 19.02N$
$\therefore \vec{F}_{NET} = m\vec{a}$; $19.51 = 1\vec{a}$	$\therefore F_{NET} = ma$; $19.02 = 2\vec{a}$
$\vec{a} = 19.51\,m/s^2$ back	$\vec{a} = 9.51\,m/s^2$ forward

#15 Can't do → info not given.

#16 a) According to Newton's 3rd Law,

$F_{ground\ up\ on\ individual} = 2.3F_g$ $\qquad$ $2.3 \times$ body weight $= 2.3F_g$

b)



$\vec{F}_{NET} = \Sigma\ \text{Forces} = 1.3F_g\ [\text{UP}]$

c) $\vec{V}_1 = 0\,m/s$

$\vec{V}_2 = ?$

$\Delta t = 0.25\,s$

$\vec{a} =$

$\vec{F}_{NET} = m\vec{a}$

$1.3F_g = m\vec{a}$

$1.3mg = ma$

$a = 1.3g$

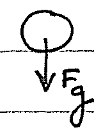
$= 12.74\,m/s^2$

$\vec{V}_2 = \vec{v}_1 + \vec{a}t$

$= 0 + (12.74)(0.25)$

$= 3.185\,m/s$

d) Once they are airborne,



$\therefore \vec{a} = -9.8\,m/s^2$

$\vec{V}_1 = 3.185\,m/s$

$\vec{a} = -9.8\,m/s^2$

$\vec{V}_2 = 0\,m/s$

$\Delta\vec{d} = ?$

$\vec{V}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$

$0 = (3.185)^2 + 2(-9.8)\Delta\vec{d}$

$\Delta\vec{d} = 0.52\,m$